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# Pride and Prejudice: Learning How Chronically Ill People Think about Food

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## ABSTRACT

In this paper, we describe a formative study to learn how one chronically ill population thinks about food, mentally organizes food, and interprets consumption-level icons. We found that many participants let their pride influence their choices, resulting in preferred interfaces that they could not accurately interpret. The results indicate that participants organized food in similar ways, had difficulty reading from their preferred consumption-level icons, and wanted to combine multiple interface designs when searching for food.

## Author Keywords

Paper prototyping, nutrition, chronically ill, health care.

## ACM Classification Keywords

H.5.2 User Interfaces: Prototyping, Screen Design.

## INTRODUCTION

Chronic diseases, such as end stage renal disease (ESRD), diabetes, and heart disease, account for 46% of global illnesses [7]. People with these chronic illnesses must monitor their nutrition rigorously to ensure they are limiting their carbohydrates, calories, fats, proteins, and/or nutrients. A failure to adequately monitor their nutritional intake can lead to further health complications and death.

Our target population is ESRD patients who have strict limits on fluid and sodium. Many people in our user group cannot perform simple calculations and have varying literacy levels [2]. Indeed, the dialysis ward from which we recruit participants is an urban, public facility where the patient literacy rate is low, so we cannot expect them to enter the nutritional content of a food item or even type the name of the food.

We are creating a PDA application to help chronically ill people monitor and maintain their nutritional intake. We chose to use a PDA because it has sufficient computational power and memory to create an application that can automati-

cally compute and record dietary intake; a color screen to easily show non-textual information; the ability to provide real-time feedback to patients to make improved decisions about diet on a prospective basis; and quick input mechanisms for patients to record information anywhere, anytime. For our application, the primary method to input food is by scanning the bar code on the package. However, many foods do not have bar codes to scan (e.g. fresh produce, home cooked meals and restaurant food).

We performed a formative study in the development of our nutritional monitoring application to aid us in designing an interface to manually select food items. Searching for a specific food item with a non-textual interface is a complex task, thus we had to research how to search for food before developing the application. The purpose of the study was to:

- Learn how the target ESRD population thinks about and mentally organizes food items.
- Determine how to visually categorize/organize foods so that participants may find them in the application.
- Choose appropriate icons for displaying consumption-level information: graphical, numerical, or a combination.
- Select appropriate warnings to inform participants that they have reached their consumption limit for a nutrient.

The findings from our formative study show that the target ESRD population organizes food in similar groupings, prefer a combination of interfaces when searching for individual food items, prefer graphical consumption-level icons and understand warnings, all of which will help guide our design. Throughout the study, however, we noted that the participants were *proud* of their abilities, and warned us that other participants *may not be as talented as them*. This often affected their preferred choice of interface to such an extent that they chose interfaces they did not fully understand.

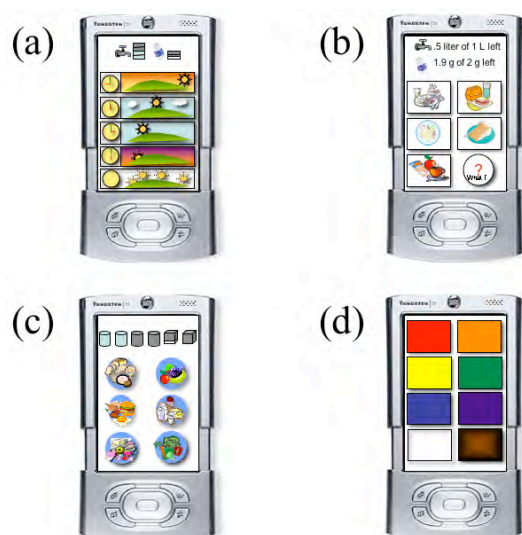
## STUDY DESIGN

Our qualitative study used low fidelity, paper prototypes that showed individual food items, top-level interface designs, consumption-level icons, and intake warnings. We interviewed patients, renal dieticians, nurses, and nephrologists in the development of the icons and interfaces. Paper prototypes have been successfully used to create PDA interfaces for people with little technical experience, varying literacy levels [3] and amnesic [9] and aphasic [4] populations.

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**Figure 1. Top-Level Interfaces: (a) Time of Day, (b) Type of Meal (c) Food Groups, and (d) Colors.**

### Design and Procedure

Participants worked with four sets of paper prototypes: individual food item and prepared meal cards, top-level interface cards, consumption-level icon cards, and warning consumption-level icon cards. For the first task, we asked participants to organize the individual food item cards into groupings that made sense to them by placing the cards in piles. We then showed participants four randomly selected prepared meal cards (e.g. spaghetti, pancakes, or pizza) and asked participants to select from their food item piles the individual foods that made up the prepared meal. After each prepared meal card, they were allowed to adjust their piles. We recorded how the items were organized, how the organization changed after each prepared food card, and if participants could identify all of the individual food items that were in a prepared meal. The primary goal of this task was to understand how participants mentally organize foods so that we can mimic that organization in our application.

For the second task, we showed the participants four types of top-level interfaces as shown in Figure 1 - foods grouped by time of day, type of meal, color of the food, and the six food groups. Participants were asked to identify each interface button, identify the theme of the interface, and tell us where they would find specific, predetermined food items (e.g. where would you find an egg?). The goal of this task was to verify the results from task 1 as well as to test the intuitiveness of food categorizations that participants were unlikely to come up with on their own.

In the third task, participants viewed the consumption-level icons one at a time in random order. We asked their preferred icons for water and sodium consumption, how much was consumed according to the icon, and how they came to their conclusions. The goal was to determine how to display the amount of fluid and sodium consumed.

For the final task, we showed the participants consumption-level icon warnings. Three types of warnings were tested - the consumption-level icons colored red, the background of the consumption-level icons colored red, and the consumption-level icons colored red with a pop-up window. All warnings had an octagon-shaped stop sign symbol with an icon representing fluid and/or sodium to let participants know which nutrient was over prescribed intake levels. Participants were asked what each warning meant and which warning they preferred. The goal was to determine how to alert a participant that they have consumed too much fluid or sodium.

### Participants

Eight participants with ESRD volunteered for the study (five women and three men). A typical ESRD patient can consume only one liter of fluid and two grams of sodium per day<sup>1</sup>. Even though all participants periodically meet with a nutritionist, half of the participants were not sure how much water they were allowed to consume in a day and seven participants did not know their daily nutrient limits. Five participants admitted to having difficulty tracking their fluid and/or nutrition consumption.

All of the participants had high school degrees. They had varying computer experience (from daily to monthly). Seven of the participants thought a nutrition monitoring application would be useful and they would use it. However, five participants said they did not trust technology.

### FINDINGS

The key findings to our study were:

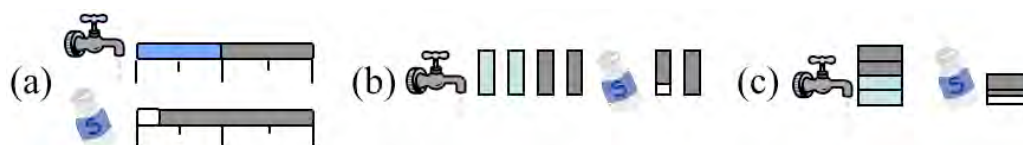
- Participants organized food items similarly.
- Participants preferred an interface that combined Time of Day and Food Groups, even though that was not how they organized the food in the first task.
- Participants were not able to read their preferred consumption-level icon accurately, but could read the fill-up icon.
- Participants understood warnings, despite not understanding indicator progression.

In this section, we present in more detail the results for each task and how *pride* and *prejudice* factored into our study.

### Food Organization

When participants were initially given the individual food item cards, half of the participants organized the cards by what they could or could not eat, whereas the other participants organized the cards by food groups in addition to two piles of cards that had what they could and could not eat. The latter categorization was more complicated because the food group piles had cards the participant was not supposed to eat, but did occasionally. The participants who organized by food groups were quick to point out that they knew the food groups and that was why they organized the food that way. However the number of food groups ranged from the standard USDA six food groups up to nine food groups. This showed us some participants tried to organize

<sup>1</sup>The amount of fluid and sodium consumption allowed varies among patients.



**Figure 2. Consumption-Level Icons: (a) Horizontal Icon, (b) Vertical Icon, and (c) Fill-Up Icon.**

food similar to how they were taught by their nutritionist, but did not fully understand the categorization.

Overall, participants were able to identify the individual food items that made up the main prepared meal in the picture. However, a majority of the participants did not talk about what food items made up the side dishes in the picture. After each prepared meal card, participants quickly reordered the piles based on frequency, but kept the membership of each pile the same. We observed that participants had similar piles in regards to what they could and could not eat in addition to frequency organization within piles.

### Top-Level Interface Designs

Participants preferred a combination of Time of Day and Food Group interfaces even though they were shown the four interface designs individually. The Food Group classified interface was the second preferred interface. In this section, we discuss the findings from each of the four interfaces.

#### Food Groups

All but one participant immediately identified the theme of the Food Groups interface. Some participants did not identify the individual buttons correctly - they used nutrient names instead of food group names (e.g. a participant said the dairy icon was phosphorus. Dairy is high in phosphorus, but it is not listed as a food group), but did press the correct interface button when searching for specific foods. Participants all agreed on where specific food items (e.g. bagel, yogurt) should be in the interface - even for more difficult food items like sandwich (protein) and banana pudding (fruit).

#### Time of Day

All but one participant immediately identified the theme of the Time of Day interface. Seven participants could identify specific times on the buttons, but found it difficult to identify the anytime button. The anytime button was commonly thought of as an evening button. Half of the participants could not tell time, but used the cues from the sun pictures to identify the icons. Everyone agreed on where specific food items such as coffee, bagel, and steak should be in the interface. However, there was some disagreement on where snack foods like cookies and candy bars should be located (evening, afternoon, and/or anytime).

#### Type of Meal

Seven of the participants understood the theme of the Type of Meal interface, but could not initially identify all of the interface buttons correctly depicting each type of meal.

When participants were prompted to identify which button they would press when searching for a specific food item, they identified the correct button and named it correctly. Participants agreed on where easy individual food items (e.g. cereal and coffee) should be located in the interface, but disagreed wildly with the more difficult items (e.g. bread).

#### Colors

Everyone understood the theme and identified each color button correctly for the Colors interface. Participants only agreed on where one specific food item (milk) should be in the interface (white button). The other food items had many interesting answers. For example, an egg could be stored in white, yellow, brown, or orange depending if you think of how an egg is prepared or the types of eggs you buy. Overall, participants agreed that the color interface was not a feasible interface when searching for foods.

#### Consumption-Level Indicators

Seven of the participants preferred an icon representing water to be the chemical formula ( $H_2O$ ) or the word "water" spelled out. Participants who selected text-based icons were proud that they knew how to read and/or knew basic chemistry. The participants warned us that other patients may not be able to understand text because they did not have the same amount of education. Conversely, most of the participants preferred a graphical icon for sodium and did not know the icon example "Na," was the chemical formula for sodium.

We used two types of consumption-level icons - text-based and graphical. Within these two groups, we split the icons into two more groups - horizontal and vertical spatial orientation as shown in Figure 2. A majority of the participants preferred the horizontal consumption-level icon.

Participants were asked how much water and sodium had been consumed in each icon. The participants confidently told us how much was consumed in each icon and did not equivocate telling us the icons were intuitive. However, half of the participants did not read their preferred icon correctly. They used metrics they were unfamiliar with and yet were proud that they used the same metrics as the clinicians. For instance, one participant said that the half way filled indicator looked like it had 10,000cc or 1.5 cans of coke. The 1.5 cans of coke is accurate, however 10,000cc is 10 liters of water (obviously too much for someone restricted to one liter of fluid per day). Consumption-level icons that had words were even more confusing for participants - they were not sure about how to use percentages and were unfamiliar with standard acronyms for liters and grams. The fill-up consumption-level icon shown in Figure 2 was the only icon read correctly by all of the participants.

### Warnings

All participants preferred the consumption-level icons to turn red because they felt it gave enough of a warning without too much color. However, the group was strictly divided on the use of pop-ups. The participants either hated the inconvenience of having to tap another window (the pop-up window) or loved the idea that the application would not let them proceed until the warning was acknowledged.

### DISCUSSION

By law, ESRD patients see a renal dietician regularly who educates them about nutrition. This probably influenced how many participants initially organized individual food item cards into similar groupings based on food groups. However, the food groups they chose were not always in agreement with the USDA food groups. In addition, participants have workbooks that describe what foods are high in fluid, sodium, phosphorus, etc. Thus, many of the participants grouped food items by their nutritional content. The reorganization of their piles with respect to the frequency of food items identified in prepared meals shows that participants want to find things quicker and have an interface that adapts to what they eat. Research has shown that people prefer personalized interfaces when searching for food items in grocery stores [1]. More research will have to be done to see if this population eats the same food and could benefit from personalization.

The preferred interface combination of Food Groups and Time of Day may be cultural and influenced by their illness. Participants preference of the Food Groups top-level interface mock-up is not surprising since half of the participants organized individual food item cards into food groups during the first task. Even though some participants were not able to initially identify the theme of some interfaces, they were able to correctly name the individual buttons when asked where they would find individual food items. This shows us that given more time to look at interfaces, participants can figure out where to search for food items.

The majority of participants preferred graphical consumption-level icons that required some basic mathematical skills to understand how much could be consumed. We found that participants were not able to read their preferred consumption-level icon - this can be explained by research that showed many chronically ill patients cannot do basic math [8]. Participants could read the fill-up consumption-level icon correctly. We think the fill-up icon is more reflective of how they think about fluid and sodium. Participants mentioned the indicator was like a cup filling up and earlier in the interview discussed how they use cups to monitor their fluid consumption. The fill-up icon used the participant's language - a key principle in designing interfaces [6].

Participants understood the warnings because of conventional stop symbols used. However, these symbols may be culturally linked and should be researched for other cultures. Researchers must also study if users immediately see the warnings because it has been found that users in active environments do not notice interface changes quickly [5].

In general, we found that participants were proud of having learned the "correct" or "scientific" way to talk about food, even if they did not understand the terms they used. We feel that we can utilize this eagerness to perform when getting the participants to adopt the nutritional monitoring application. The key is to make ESRD patients feel like part of an elite group to be using the PDA while simultaneously ensuring that the interface is such that they understand when to stop consuming fluid or a certain nutrient.

### CONCLUSION

In this paper, we presented our formative study on how chronically ill people think of food. We found that people with ESRD organize food in similar groupings, prefer graphical consumption-level icons that closely reflect how they think about fluid and sodium in everyday life, understand warnings, and prefer a combination of interfaces when searching for food. Participants were eager to show us how much they knew and sometimes prejudice of peers who did not have the same knowledge base, but their preferences were not always in line with the design they could accurately read. From our study, we suggest that designers should take the *pride* of end users into account when working with users and interpreting their comments and preferences.

### ACKNOWLEDGMENTS

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